UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
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January 22, 1993

MEMORANDUM

SUBJECT: Review of "Draft Work Plan for the Bioremediation Treatability Testing for the Standard Chlorine of Delaware, Inc." (93-R03-001)

FROM: Mary Randolph MR
Microbiologist

TO: Katherine Lose, RPM, (3HW42)
DE/MD Section
EPA, Region 3

Per your request dated December 22, 1992, the "work plan for the Bioremediation Treatability Testing for the Standard Chlorine Site", has been reviewed for technical merit and appropriateness by Barbara Wilson (Dynamac Corporation), Hugh H. Russell, and me. If you have any questions or the Technology Support Center can be of further assistance, please contact me at 405-436-8616.

General Comments:

The objectives of the proposed treatability study is to evaluate the technical feasibility of using biological treatment for remediation of soils and sediments at the site. The specific type of bioremediation technologies that might be used is not discussed.

Since this is a "first cut" to determine if bioremediation is feasible at the Site and the major limiting factor in such decisions is monetary, it is difficult to find fault with the document. However, it would seem appropriate that replicates of each proposed test condition (inhibited control, nutrient amended, and nutrient amended/inoculated) at the appropriate time points would certainly tighten any data generated.

Specific comments concerning the document are as follows:

Page 2-5. Remedial Technology Description

It was stated in the document that most of the chlorinated solvents work conducted to date has focused upon using carbon sources such as toluene, propane, and methane. While the named carbon sources have been shown effective as electron donors or co-substrates in

biological systems, other electron donors also have been utilized with varying degrees of success. Electron donors which may be evaluated in an anaerobic system are sugars such as glucose, alcohols such as ethanol and volatile fatty acids such as butyric. Any or all of these electron donors may work better than toluene in an anaerobic system.

Page 3-1. General Approach

Column studies will be conducted to provide an assessment of the feasibility of in-situ soil flushing/treatment. Care should be exercised when attempting to scale any laboratory experiment to the field. While columns such as this may determine the desorption coefficient of contaminants, the effects of the hydrogeology on remediation most likely will not be determined.

Page 4-3. Aerobic Biotransformation Testing Procedure

The proposed aerobic treatments are to be soil/water slurries with nutrient and inoculant amendments. Biological treatability studies should mimic the physical environment where remediation will occur. Soil/water slurries are not appropriate models for vadose zone materials that might be treated in situ. The test treatments should be conducted at the same water content as the actual material that will be remediated. Treatment microcosms should be constructed using an appropriate soil moisture content.

The soil/water slurry treatments would be appropriate if a slurry-phase bioreactor were to be the method of bioremediation. Such treatments could be used to optimize the solids content of the slurry, nutrient additions needed, and agitation needed for adequate aeration. However, the treatments also must be able to account for volatilization resulting from stirring or agitation.

One of the proposed treatments is to involve amendment with nutrients plus biomass from an activated sludge wastewater treatment plant. In general, the addition of inocula to soil has not been shown to be useful in bioremediation efforts. The ability of the inocula to survive and sustain itself once added to soil has not been demonstrated. We recommend that the treatability study focus on stimulation of indigenous microorganisms to degrade the chlorobenzenes.

However, inocula may be used successfully in a surface-based bioreactor to treat contaminated air or water streams pumped from the subsurface. In the controlled environment of a bioreactor, optimal conditions for survival of added microorganisms can be better maintained.

The inhibited control is to be prepared by adding mercuric chloride to the test flask. Mercuric chloride may not adequately sterilize the soil for the 60 days of the study unless added at concentrations that might change the chemical and physical properties of the soil.

Certainly this should be studied prior to initiation of the studies. Other sterilization techniques such as autoclaving soil has proved satisfactory for some researchers; however, autoclaving also may change chemical and physical properties of some soils.

Page 4-4. Anaerobic Biotransformation Testing Protocol

The proposed design of the anaerobic treatability studies has the same problems as the aerobic study. Specifically, the soil moisture content for the anaerobic treatments should be the same as the soils that will be remediated; addition of inocula to soil has not been shown to be useful in bioremediation efforts; and, use of mercuric chloride to prepare the inhibited control should be carefully considered.

Performance will be assessed by analyzing slurry samples at the following intervals: Day 0, 10, 30, 60. A 60 day interval for an anaerobic treatment assessment conceivably could be much too short of a time frame to generate significant and reliable data.

Page 4-5. Column Testing

The objective of the soil column testing is to simulate the potential for anaerobic in situ soil flushing/bioremediation of the unsaturated zone. The purpose of maintaining anaerobic conditions in the test columns is not clear. In a field situation, maintenance of strict anaerobic conditions in the unsaturated zone for in situ soil flushing would be difficult in the absence of flooded conditions. The use of a third column for the study of surfactant addition may be worthwhile. Many soil flushing methods make use of surfactants, emulsifiers, and/or polymers to increase removal of sorbed contaminants from subsurface solids.

Page 4-8.

The water apparently will be allowed to infiltrate under the influence of gravity unless the infiltration rate is too slow, in which case pressure will be used. Consideration should be given for use of a pump to apply the water at a defined rate, since soil flushing at field scale will require controlled application and capture of the flushing solutions.

Page 4-9. Methanotrophic Option

Methane, phenol, and other compounds have recently been used at pilot-scale for the cometabolism of recalcitrant chlorinated organics such as trichloroethylene. Although cometabolism has not been used to date for bioremediation of chlorinated benzenes, it is possible that chlorinated benzenes may be treated in this manner with the appropriate primary substrate. Batch studies using unsaturated soils in serum bottles would be a good preliminary treatability study.

Additional recommendations:

The majority of the contamination is comprised of mono-, di-, tri-, and tetrachlorobenzenes in the unsaturated zone and in soil piles. All of these compounds are both volatile and amenable to aerobic biodegradation and could be good candidates for bioventing and/or soil vacuum extraction technologies. Bioventing may be an ideal method for reducing the contaminant mass. However, some contaminant concentrations in some locations may be high enough to potentially inhibit microorganisms. Reinjection of the effluent stream from those areas into a less contaminated portion of the site would allow bioremediation of the effluent stream.

Nevertheless, the feasibility of implementing vacuum extraction and/or bioventing should clearly be considered further. These technologies have successfully been implemented in the field at other Superfund/RCRA/UST sites and have largely been responsible for significant contaminant concentration reduction in the unsaturated zone. An Issue Paper entitled "Evaluation of Soil Venting Application" which outlines the major principles associated with this technology is enclosed.

cc: Rich Steimle, OS-110W
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